DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 13 August 2008 has been entered.

2. Claims 3-5 are pending.

Claim Objections

3. Amendments to claim 4 in the response submitted on 04 August 2008 are acknowledged, and objections with respect to the informalities indicated in the Office action dated 12 May 2008 are withdrawn.

Claim Rejections - 35 USC § 103

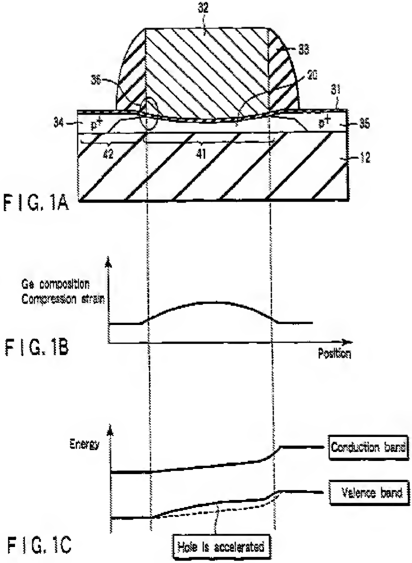
4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tezuka et al. (US 7,009,200) (hereinafter Tezuka) in view of Zhang et al. (US 2003/0011009) (hereinafter Zhang).

6. **With respect to claim 4,** Tezuka (e.g. Figures 1A-1C) teaches a normally on PMOS field effect transistor comprising:

- A source 34 formed by a source material,
- A drain 35 formed by a drain material, and
- A channel formed by a channel material,
- The source, the drain, and the channel materials being selected such that (refer to Figure 1C):
  - An upper level of a valence band of the drain material is higher than an upper level of a valence band of the channel material, and
  - An upper level of a valence band of the source material is lower than the upper level of the valence band of the channel material



Tezuka fails to teach that the source material and the drain material are different materials. *Note that Tezuka teaches that portions of the source and drain are metal silicide layers (column 4, lines 1-4). Zhang teaches that the source and the drain material are different materials [0010] in order to provide a lower offset current ([0005], [0045]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the field effect transistor of Tezuka with the different source and drain materials of Zhang for the benefit of lowering the offset current.

7. Claims 3 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tezuka in view of Furukawa et al. (US 4,885,614) (hereinafter Furukawa), and further in view of Hall (US 2,918,396) (hereinafter Hall).

8. **With respect to claim 3,** Tezuka (e.g. Figures 4A-4C) teaches a normally on NMOS field effect transistor comprising:

- A source 34 formed by a source material,
- A drain 35 formed by a drain material, and
- A channel 52 formed by a channel material,
- The source, the drain, and the channel materials being selected such that:
- An electronic affinity of the drain material (SiGe) is lower than an electronic affinity of the channel material (Si) (column 4, lines 59-60; column 6, lines 56-59)

Tezuka further teaches the use of a $Si_{1-u-v}Ge_uC_v$ ($1>u\geq0$, $1>v\geq0$) layer for the source material (column 8, lines 24-27).

*Note that it is inherent that the electronic affinity of germanium is less than the electronic affinity of silicon, and that the electronic affinity of silicon is less than the electronic affinity of the diamond allotrope of carbon.

Tezuka fails to explicitly teach that an electronic affinity of the source material is higher than the electronic affinity of the channel material because Tezuka does not disclose which allotrope of carbon is used in the $Si_{1-u-v}Ge_uC_v$ layer, and Tezuka does not

explicitly teach the benefits of using a silicon-carbon alloy (without germanium). Tezuka further fails to teach that ***the source material and the drain material are different materials***.

Furukawa teaches that the diamond structure of carbon is used in a silicon-germanium-carbon alloy in order to decrease the misfit dislocation in alloyed semiconductor devices (column 1, lines 40-42) because the diamond structure of carbon contributes a smaller lattice constant to the alloy (column 3, lines 16-23).

Hall teaches that silicon carbide is a desirable material to use in the fabrication of semiconductor transistors because it can remain extrinsic at high temperatures, whereas devices fabricated using germanium do not function effectively at elevated temperatures because of a reduced contribution from minority carrier injection processes at a P-N junction (column 1, lines 32-51).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the transistor of Tezuka having a $Si_{1-u-v}Ge_uC_v$ source material with the diamond structure of carbon of Furukawa for the benefit of decreasing the misfit dislocation in alloyed semiconductor devices because the diamond structure of carbon contributes a smaller lattice constant to the alloy and to further provide the transistor of Tezuka as modified by Furukawa with the silicon-carbon alloy of Hall for the benefit of fabricating a semiconductor transistor that can remain extrinsic at high temperatures.

Furthermore, Tezuka in view of Furukawa and Hall teaches that the source material and drain material are different materials (e.g. the source is formed of silicon carbide and the drain is formed of silicon germanium).

9. **With respect to claim 5,** Tezuka teaches an integrated circuit (column 1, lines 39-41), comprising:

- Normally on PMOS type and normally on NMOS type field effect transistors (column 7, lines 55-58), wherein:
- The normally on NMOS field effect transistor comprises (refer to Figures 4A-4C):
- An NMOS source 34 formed by an NMOS source material,
- An NMOS drain 35 formed by an NMOS drain material, and
- An NMOS channel 52 formed by an NMOS channel material,
- The NMOS source, NMOS drain, and NMOS channel materials being selected such that:
- An electronic affinity of the drain material (SiGe) is lower than an electronic affinity of the channel material (Si) (column 4, lines 59-60; column 6, lines 56-59)

Tezuka further teaches the use of a $Si_{1-u-v}Ge_uC_v$ ($1>u\geq0$, $1>v\geq0$) layer for the source material (column 8, lines 24-27).

*Note that it is inherent that the electronic affinity of germanium is less than the electronic affinity of silicon, and that the electronic affinity of silicon is less than the electronic affinity of the diamond allotrope of carbon.

- The normally on PMOS field effect transistor comprising (refer to Figures 1A-1C):
- A PMOS source 34 formed by a PMOS source material,

- A PMOS drain 35 formed by a PMOS drain material, and
- A PMOS channel formed by a PMOS channel material,
- The PMOS source, the PMOS drain, and the PMOS channel materials being selected such that (refer to Figure 1C):
    - An upper level of a valence band of the PMOS drain material is higher than an upper level of a valence band of the PMOS channel material, and
    - An upper level of a valence band of the PMOS source material is lower than the upper level of the valence band of the PMOS channel material

Tezuka fails to explicitly teach that an electronic affinity of the NMOS source material is higher than the electronic affinity of the NMOS channel material because Tezuka does not disclose which allotrope of carbon is used in the $Si_{1-u-v}Ge_uC_v$ layer, and Tezuka does not explicitly teach the benefits of using a silicon-carbon alloy (without germanium).

Furukawa teaches that the diamond structure of carbon is used in a silicon-germanium-carbon alloy in order to decrease the misfit dislocation in alloyed semiconductor devices (column 1, lines 40-42) because the diamond structure of carbon contributes a smaller lattice constant to the alloy (column 3, lines 16-23).

Hall teaches that silicon carbide is a desirable material to use in the fabrication of semiconductor transistors because it can remain extrinsic at high temperatures, whereas devices fabricated using germanium do not function effectively at elevated temperatures because of a reduced contribution from minority carrier injection processes at a P-N junction (column 1, lines 32-51).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the NMOS transistor of Tezuka having a $Si_{1-u-v}Ge_uC_v$ source material with the diamond structure of carbon of Furukawa for the benefit of decreasing the misfit dislocation in alloyed semiconductor devices because the diamond structure of carbon contributes a smaller lattice constant to the alloy and to further provide the transistor of Tezuka as modified by Furukawa with the silicon-carbon alloy of Hall for the benefit of fabricating a semiconductor transistor that can remain extrinsic at high temperatures.

Response to Arguments

10. Applicant's arguments with respect to claim 4 have been considered but are moot in view of the new ground(s) of rejection.

11. Applicant's arguments filed 04 August 2008 have been fully considered but they are not persuasive.

12. In response to applicant's arguments against the references individually, that none of Tezuka, Furukawa, or Hall teaches that the source material and the drain material are different materials (remarks at page 5, paragraph 4 and page 6, paragraphs 1-2), one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In the instant case, Tezuka teaches a drain made of silicon germanium (column 4, lines 59-60; column 6, lines 56-59). Tezuka further teaches that

it is preferable to use a $Si_{1-u-v}Ge_uC_v$ ($1>u\geq0$, $1>v\geq0$) layer for the source material (column 8, lines 24-27). Furukawa (column 1, lines 40-42) teaches that the diamond structure of carbon is used in a silicon-germanium-carbon alloy in order to decrease the misfit dislocation in alloyed semiconductor devices because the diamond structure of carbon contributes a smaller lattice constant to the alloy (column 3, lines 16-23). And, Hall teaches that silicon carbide is a desirable material to use in the fabrication of semiconductor transistors because it can remain extrinsic at high temperatures, whereas devices fabricated using germanium do not function effectively at elevated temperatures because of a reduced contribution from minority carrier injection processes at a P-N junction (column 1, lines 32-51). Thus, Tezuka in view of Furukawa and Hall teaches that the source material (silicon carbide) and the drain material (silicon germanium) are different materials.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. Wendy Kuo whose telephone number is (571)270-1859. The examiner can normally be reached Monday through Friday 7:00 AM to 4:30 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sue A. Purvis can be reached on (571) 272-1236. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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